EUDET: Detector R&D Towards the International Linear Collider[1]

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Abstract:

EUDET is an initiative supported by the European Union to improve infrastructures for detector R&D, in particular for the International Linear Collider (ILC). The programme is focused on providing support for larger scale prototype experiments as well as on facilitating collaborative efforts. The project encompasses developments for vertex detectors, gaseous and silicon tracking, and highly granular electromagnetic and hadron calorimeters. In total 31 European institutes participate in the project, plus more than 20 other institutes in Europe and abroad which are associated members and linked to the progress and later exploitation of the infrastructures. In all its activities EUDET is closely linked to the internal R&D collaboration for the ILC detector. The R&D programme will be described and results of the R&D efforts will be presented.

Over the past years the detector R&D for the ILC has identified several candidate technologies for vertex and tracking detectors and calorimetry which meet the challenging demands for the physics at the ILC. Now the R&D efforts enter into a phase where these technologies have to be extended to larger prototype detectors to verify their feasibility and to optimise the overall detector performance. The EUDET project provides with support from the European Union a framework for the development and construction of larger prototypes for ILC detector technologies. The project started in January 2006 for a duration of four years and it encompasses the design and construction of infrastructures for vertex and tracking detectors as well as electromagnetic, hadronic and forward calorimeters. Most of these infrastructures will be initially commissioned at DESY but they are designed to be movable such that they can later be exploited at other laboratories in Europe and abroad.

Event though EU funding can only be allocated to European groups the project is open to world-wide collaboration. Several non-European institutes are associated and contribute to the design and construction of the infrastructures anticipating the subsequent exploitation of the infrastructure.

The layout of the project is sketched in Figure 1. One important pillar is the establishment of a detector R&D network which intensifies the collaboration in Europe. All infrastructures are designed in an international collaboration and appropriate communication and management structures have been set up. Another aspect is the development of a common simulation and analysis framework. This includes the analysis of upcoming testbeam campaigns of individual detectors as well a combined experiments, but also contributions to the simulation work required for the design of the ILC detectors. The network is complemented by work on the improved simulation of hadronic showers incorporating testbeam results from highly granular calorimeters and by access to state–of–the–art deep submicron technology for chip development required for almost all modern particle detectors.

The testbeam infrastructure consists of a large bore magnet and a high-precision beam telescope. The magnet supplied by the associated partner KEK (Japan) provides a field of about 1 Tesla in a bore of 85 cm diameter. It possesses a light-weighted coil and a stand-alone He supply thus

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making it ideally suited for experimentation in a testbeam. The cooling and control infrastructure has been set up at DESY and the device is available in the testbeam area. A multilayer pixel telescope in MAPS technology is under construction with the potential of a space resolution of about 1 µm. Pixel detectors in DEPFET technology are used to independently validate the performance of the device. A first version of this telescope will be available in summer 2007 and commissioned in the DESY testbeam.

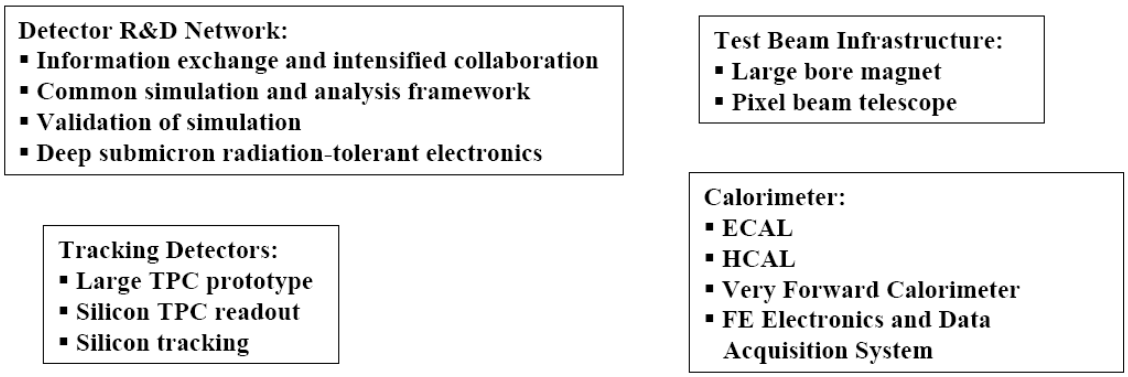

Figure 1: Sub-projects of the EUDET programme.

The two main options for the main tracker of the ILC detector are part of the EUDET programme. A large TPC fieldcage is under construction to be equipped with GEM or MicroMegas based readout structures which have demonstrated in small prototypes their potential to achieve single point space resolutions of 100 µm or below. The development of modern readout electronics adapted for micro pattern gas detectors is part of the TPC project. Furthermore, it is complemented by the development of a silicon pixel based readout supporting the design and procurement of the TimePix chip which combines the ultimate resolution of a pixel device with a drift time measurement to provide three dimensional tracking capability.

The development of a large silicon strip tracking detector is also supported. In the framework of EUDET large and light mechanical structure for the silicon strip detectors are developed as well as prototypes for cooling and alignment systems. In addition, the design of multiplexed deep submicron front-end electronics is supported. Also in this area significant progress has been achieved since the start of the project.

The anticipated physics at the ILC requires calorimeters with unprecedented energy resolution, in particular for jets. Particle flow algorithms based on highly granular electromagnetic and hadronic calorimeters are considered to be a promising candidate to achieve the goals. In EUDET scalable prototypes for the main calorimeters are developed and constructed, together with developments of silicon sensors and calibration systems. It also includes positioning and calibration systems for the very forward calorimeters. This is complemented by the development of a common front electronic and data acquisition system for all calorimeters.

The EUDET infrastructures are open to be used by other interested international groups which perform R&D on particle detectors for the ILC, other high energy physics projects or other scientific research work. As part of the EU programme travel support to European groups using these installations can be provided in the framework of the Transnational Access instrument.

The talk and the paper will provide more details on the EUDET project and in particular discuss the significant progress achieved and future plans. Examples of achievements are the TimePix chip, the commissioning of the large bore magnet and the first operational version of the beam telescope. In 2008 most of the remaining EUDET infrastructures are to be completed such that they can be exploited starting in 2009.